

BENEFICIAL EFFECT OF ALLIUM SATIVUM AND ALLIUM TUBEROSUM ON EXPERIMENTAL HYPERLIPIDEMIA AND ATHEROSCLEROSIS

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Background: Garlic has been used as a dietary agent through-out the world. Different culture used different varieties of garlic depending upon their ecological productivity. In India *Allium sativum* species of garlic is very commonly used, while another species of garlic named *Allium tuberosum* is used in South-east Asia, China and North-east part of India. Both the species are important constituent of customary diet in Indian and Chinese food. The main aim of this study is to compare the potency of these two species for their antihyperlipidemic effect and curative potential against atherosclerosis. **Methods:** Forty-three guinea pigs were fed cholesterol (0.5 g per kg, body weight) for an initial period of 4 weeks. Cholesterol was then discontinued and they were divided into three groups. Group-I (n=7) was fed stock diet while group-II (n=18) was given 2 gm. per kg body weight of *Allium sativum* daily for 4 weeks. Group-III (n=18) was supplemented by *Allium tuberosum* species of garlic (2 gm/kg body weight) daily for 4 weeks period. Fasting blood samples were collected at onset of study, at 4 weeks duration and finally at the end of study (8 weeks period), for estimation of serum cholesterol, serum triglycerides, LDL-C, HDL-C, VLDL-C and atherogenic index. At 8 weeks duration all the animals were sacrificed for grading of atherosclerotic lesions. **Results:** In present study both species of garlic (*A. sativum*, *A. tuberosum*) showed significant hypolipidemic activity as they reduced serum cholesterol, triglyceride, LDL-C and atherogenic index in hyperlipidemic guinea pigs ($p<0.01$). The significant rise in HDL-C level was not observed. On comparison between *Alliums sativum* & *Alliums tuberosum* it was found that *Allium tuberosum* very significantly reduced serum cholesterol and serum triglycerides, LDL-C and atherogenic index ($p<0.05$). *Allium tuberosum* species of garlic was found more potent ($p<.05$) than *Allium sativum* in reducing severity of atherosclerosis. **Conclusion:** It can be concluded that *Allium tuberosum* species of garlic is a more potent hypolipidemic and antiatherosclerotic agent as compared to *Allium sativum*.

Keywords: *Allium sativum*, *Allium tuberosum*, Hyperlipidemia, Atherosclerosis

INTRODUCTION

Naturally occurring Sulphur containing compounds present in the *Allium* family may influence plasma cholesterol and atherosclerosis.¹ These substances are found especially in garlic, onion and leeks, the most prominent of these being garlic.² The garlic preparations showed significant reduction on serum cholesterol levels in clinical³ as well as experimental studies⁴. *Allium sativum* has been reported to exhibit beneficial effects in atherosclerosis and ischemic heart disease in experimental animals and human beings.⁵⁻⁶

Most commonly used species of garlic in India is *Allium sativum*, while *Allium tuberosum* species is mainly consumed and cultivated in south-east Asia, China and North-east part of India. Since these plants form the constituent of customary diet in Indian and Chinese food, their chronic ingestion is safe and is expected to be of benefit largely in persons prone to hyperlipidemia and atherosclerosis. Till now no study has been carried out to compare the beneficial effect of these two species of garlic against hyperlipidemia hence this study was under taken to discover the relative potency of these agents with

respect to their anti-hyperlipidemic effect and curative potential against atherosclerosis.

MATERIAL AND METHODS

The study was conducted in healthy guinea pigs of either sex weighing 510±42 gm. These were randomly divided into three groups. Group-I (n=7), Group-II (n=18), Group-III (n=18). In all three groups experimental hyperlipidemia was induced by feeding cholesterol (500 mg/kg body wt. per day) in 5 ml milk, for 4 weeks. After that, cholesterol feeding was stopped and Group-II and Group-III animals were supplemented with (4 gm/kg body weight per day) of *Allium sativum* and *Allium tuberosum* species of garlic, respectively for 4 weeks. The garlic bulbs were peeled off and crushed in sufficient water and homogenized in blender before tube feeding to the animals. Group-I animals were given 1 ml of normal saline for 4 weeks period.

All the animals were anesthetized with pentobarbiton (35 mg/kg i.p.) and fasting blood samples were collected carefully from the right ventricle of heart. The blood samples were collected at on set of study, at 4 weeks duration and finally at

the end of study that is at 8 weeks period, for the estimation of serum cholesterol⁷, triglyceride⁸, LDL-C, HDL-C⁹, VLDL-C and atherogenic index. At 8 weeks duration Aortae were excised and studied for atherosclerotic lesions which were graded as per the method described by Duff and McMillan.¹⁰ The method of grading was open. All the animals received a common stock diet (bran and fresh vegetables) and water adlib for the period of study. The results were analysed by ANOVA and Newman-Keul's procedure and Fisher's exact probability test.

RESULTS

Effect on Serum Cholesterol, Triglyceride, LDL-C, HDL-C, VLDL-C, & Atherogenic Index

Table-1 illustrates the effect of normal saline feeding and treatment with crushed *Allium sativum* and *Allium tuberosum* on hyperlipidemic guinea pigs. On comparison with Group-I both the species of garlic produce significant reduction in serum cholesterol, triglycerides, LDL-C and atherogenic index ($p < 0.01$). There was no significant rise in HDLC level. On comparison between *Allium sativum* and *Allium*

tuberosum species of garlic it was found that *Allium tuberosum* very significantly reduces serum cholesterol, triglyceride, LDL-C and atherogenic index ($p < 0.05$).

Effect on atherosclerotic lesions

The distribution of grades of atherosclerotic lesions in all the 3 groups is shown in Table-2. Since these grades do not confirm to a normal distribution curve, a non parametric test (Fisher's exact probability test) was applied to analyse the result.¹¹ For this, each set of results was arbitrarily arranged in to two groups, Group-A containing 0 to II grades and Group-B containing III and IV grades. The results of both the groups were compared and the probability of difference was calculated. *Allium tuberosum* and *sativum* was found to reduce the development of atherosclerotic lesions induced by atherogenic diet ($p < 0.01$). On comparison between these two species of garlic, *Allium tuberosum* was found more potent ($p < 0.05$) than *Allium sativum* in reducing atherosclerosis.

Table-1: Effect of *Allium sativum* & *Allium tuberosum* on lipid profile of hyperlipidemic guinea pigs

Group Lipid Profile Parameters	Group -I (n=7) Normal Saline feeding	Group -II (n=18) A. Sativum feeding	Group -III (n=18) A. Tuberosum feeding	Result of ANOVA test
S. Cholesterol	94.49±8.71	60.17*±14.31	46.70**±12.90	F _(2,40) =235.11 (P<0.01)
S. Triglyceride	91.84±5.86	65.61*±11.36	57.53**±12.28	F _(2,40) =23.92 (P<0.01)
HDL-C	11.43±0.98	12.22±1.40	12.78±1.70	F _(2,40) =2.18 (P>0.05)
LDL-C	64.70±7.70	34.82±13.09	22.42**±10.62	F _(2,40) =34.80 (P<0.01)
VLDL-C	18.37±1.17	13.13*±2.30	11.5±2.46	F _(2,40) =5.26 (P>0.05)
Atherogenic [#] Index	5.70±0.91	2.94*±1.26	1.75**±0.85	F _(2,40) =35.26 (P<0.01)

For Comparison between groups Newman-Keul's procedure was applied. * $p < 0.05$ on comparison to Group-I. ** $p < 0.05$ on comparison to Group-II & Group-I. [#]Atherogenic Index=LDL-C/HDL-C

Table-2: Effect of *A. sativum* and *A. tuberosum* on grades of atherosclerosis in hyperlipidemic guinea pigs

Group	No. of animals showing atherosclerosis				
	Grades				
	0	I	II	III	IV
Group-I	0	0	3	3	1
Group-II*	0	5	7	6	0
Group-III** [#]	0	9	6	3	0

Fisher's exact probability test is applied for p value: * $p = 0.009$, ** $p = 0.007$ on comparison to Group-I. [#] $p = 0.012$ on comparison to Group-II.

DISCUSSION

Hyperlipidemia is one of the major risk factor for the development of atherosclerosis. It is associated with high rate of cardiovascular morbidity & mortality. Various agents, which affect hyperlipidemia, are still not used for prevention or cure of atherosclerosis because of their potential toxicity and intolerance.

Garlic has been reported to minimize the adverse effects of hyperlipidemia¹² and is well tolerated as it forms one of the important constituents of kitchen recipes in India. Bordia and Verma¹³ as well as Jain¹⁴ have shown the reversibility of cholesterol induced experimental atherosclerosis in rabbits by garlic.

Among the risk factors identified for coronary artery disease, lipids are of utmost importance. Risk of coronary artery disease is proportional to the antecedent, Cholesterol level.¹⁵ Garlic contains sulphur containing compound allin, which is converted to active ingredient 'allicin' when the garlic bulb is crushed. This compound has an inhibitory effect upon the key enzymes involved in cholesterol biosynthesis, such as HMG-CoA reductase.¹⁶ Hypocholesterolemic effect of garlic is exerted by decrease in hepatic cholesterogenesis, where as the triacylglycerol lowering effect appears to be due to inhibition of fatty acid synthesis, by

mallic enzymes, fatty acid synthetase, and glucose-6-phosphate dehydrogenase.¹⁷ Garlic helps to prevent lipid implantation on the arterial wall.¹⁸ Orekhov¹⁹ suggested that garlic powder extract inhibited lipid synthesis both in normal and atherosclerotic cells cultured in vitro from human aortic cell. Jain²⁰ suggested that garlic may act by increasing the excretion of cholesterol end products and by affecting its synthesis in the liver. Aqueous garlic extract also made the LDL significantly resistant to oxidation, it may be one of the powerful mechanism accounted for the benefits of garlic in atherosclerosis.²¹ Garlic also prevents fall of HDL, which is nonatherogenic and transfers cholesterol from the periphery to the liver.²² Yeh *et al*¹⁷ shows that water soluble sulphur compounds of garlic like s-allylcysteine, s-ethylcysteine, and s-propylcysteine inhibited the cholesterol synthesis significantly on comparison to lipid soluble sulphur compounds of garlic which inhibited cholesterol synthesis slightly.

In the present study too, both the species of garlic (*Allium sativum* and *Allium tuberosum*) showed significant hypolipidemic activity as they reduce serum cholesterol, triglyceride, LDL in hyperlipidemic guinea pigs. But the significant rise in HDL was not observed. These agents were also found to confer protection against atherogenic diet induced atherosclerosis. The more potent amongst these two species was found to be *Allium tuberosum* for reduction of hyperlipidemia and atherosclerosis.

CONCLUSION

It can be concluded that *Allium tuberosum* may be a beneficial hypolipidemic and anti-atherosclerotic agent and is more potent than *Allium sativum* in hypolipidemic action.

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